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Improving Generic Science Skills of Chemistry Prospective Teachers through Implementation of Electronic Portfolio Assessment (APFE)

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Abstract

The aim of the research to show the effect of the implementation of electronic portfolio assessment toward generic science skills of chemistry prospective teachers. The research design used was "Pretest-posttest Control Group Design". Subjects of research are students of chemistry education department taking courses Practical Inorganic Chemistry at LPTK (an Institute of Teachers Training) in Central Borneo. Data collected by generic science skills multiple choice form online test, and students portfolio that uploaded as electronic portfolio. Data analysis was processed using the N-gain scores, the mean difference test and descriptive statistical analysis. The results showed that the generic science skills of chemistry prospective teachers increased significantly. The generic science skills that developed through the APFE included: direct and indirect observation, sense of scale, symbolic language, logical frame, logical consistency, causality, modeling, logical inferences, abstraction, and spatial. The results of descriptive analysis showed that the achievement level of the generic science skills of use symbolic language and modeling are higher than others. Thee advantages of implementation of APFE are: (1) improve generic science skills, especially symbolic language, spatial, sense of scale, and modeling indicators, and (2) improving reflection and self assessment.

Keywords: generic science skills, electronic portfolio assessment.

Introduction

Facing the challenges in the era of globalization, chemistry teacher candidates are expected to have the ability to think and act based on knowledge of chemistry they have. To achieve these targets, the learning paradigm of chemistry at LPTK need to be changed, as is confirmed by Brotosiswojo (2001) which states that the pattern of chemicals in the learning experience should LPTK revamping the learning model that not only emphasizes mastery of chemical concepts, but the skills of thinking, communicating processes and the results studied chemistry in high school, as well as generic skills to apply science in solving problems of everyday life. Generic science skills is the ability to think and act based on the students' scientific literate (Liliasari, 2007).

The importance of the development of generic skills in science learning is recognized by several researchers (Brotosiswojo, 2001; Mitchell, 2005; and Harris, 2007) because the skills are generic employability skills that are used to apply the knowledge (Kamsah, 2004) and as the foundation to help learners learn how to learn (Yu, 2009). Brotosiswojo (2001) states that the generic skills of science today is very important in establishing patterns of personality and life of every human being in Indonesia, because science is the foundation of generic skills in decision-making and problem solving in daily life.

Several researchers have developed generic skills through learning set that focus on processes and activities of student-centered rather than subject content (Luca and Oliver, 2002; Suyanti, 2006; Sudarmin, 2007; Liliasari, 2007). Suyanti (2006) and Sudarmin (2007) develop generic skills through courses that are integrated with practical work. Laboratory activities can be a vehicle for the development of generic science skills indicators because includes of cognitive, affective and psychomotoric aspects comprehensively. Mitchell (2004) states that a generic capability that can be developed through a chemistry lab in the laboratory include: (a) the skills to standard laboratory procedures, (b) the use of instruments in the work of synthesis and analysts, (c) monitoring through observation and measurement, documentation and systematic recording, (d) the ability to interpret data derived from observations and measurements in the laboratory, and (e) the ability to manage risks to the use of chemicals and laboratory procedures.

In some educational institutions in Indonesia, generally the researchers developed a generic science skills with reference to the indicators proposed by Brotosiswojo (2001) are categorized into indicators: (a) direct observation, (b) indirect observation, (c) sense of scale, (d) symbolic language, (e) logical frame; (f) logical inference, (g) causality, (h) mathematical modeling, and (i) establish the concept, (j) Abstaction, and (k) spatial (Liliasari, 2011; Sudarmin, 2007; and Suyanti, 2006).

Development of generic skills are generally designed through the development strategy or model of learning. Assessment as part of learning can also be a means of developing generic skills in science. Pelliccione and Dixon (2008) has developed generic skills in college students through web-based electronic portfolio assessment.

Assessment of electronic portfolios (APFE) is a collection of assignment that represent the results of learners through a definite learning period that is placed on a compact disc media (CD or DVD) and web (Gray, 2008; Cherian & Mau, 2003). E-Portfolios are an electronically published collection of portfolios selected by learners to represent their learning over a period of time. Portfolio assessment is effectively used for the assessment (Barrett, 2005). Electronic portfolios are student-centered, scalable, and support both formative and summative assessment (Kampschuur and Chatterton, 2007). Using APFE gives immediate feedback in time, more efficient, flexible, and easily modified (Halstead and Wheeler, 2009; Bhamra and Rattenbury, 2006). The results of other studies have shown that the electronic portfolio can improve the generic skills and promote learning (Molyneaux et al., 2009; Wang, 2009; Pelliccione and Dixon, 2008; Bhattacharya and Hartnett, 2007).

Based on the above background, then do research on the development of generic science skills through the implementation APFE Inorganic Chemistry lab courses. Research problem how electronic portfolios increase students prospective chemistry teacher generic science skills through APFE on Practical Inorganic Chemistry activities? The purpose of this study was to improve students' generic science skills through APFE prospective chemistry teachers.

Methodology

Subject and research design

Research subjects were students of chemistry education of LPTK at Palangkaraya enrolled on Practical Inorganic Chemistry course. The number of subjects in the control and experimental class are 30 students respectively. The study design using the "Pretest-posttest Control Group Design" (Sugiyono, 2010), with the following models:

Pre-test	Treatment	Post-Test
O_1	X	O_2
O_3		O_4

Description:
O_1: the pretest score before the treatment of the experimental class
O_2: the posttest score after treatment of the experimental class
O_3: the pretest score before learning of control class
O_4: the posttest score after learning of the control class
X : an electronic portfolios assessment (APFE)

Subject matter experiment that became the focus of research are (1) the synthesis and characterization of sodium thiosulfate pentahydrate, (2) synthesis and characterization of complex salt cis-trans potassium dioksalatodiakuokromat (III), and (3) determination of the complex coordination number of copper (II).

Practicum is conventionally carried out both on the experimental class and control class together. The treatments were given to experimental class is the implementation of electronic portfolio assessment (APFE), where the evidence chemistry teacher candidates' work-load to the site upload *http://courses.kimiawan.org* through exabis module Moodle-based e-Portfolio. APFE main components are pre-laboratory quizzes (KPA), laboratory journals, student worksheets (LKM), and laboratory reports. KPA in the form of multiple choice, short answers while the LKM is a short answer question. The two quizzes are done online.

Techniques of Data Collection

Generic science skills data drawn from pretest-posttest given before and after learning. This test was done online.

Data Analysis Research

Generic science skills is calculated through the normalized gain scores (N-gain). N-gain score is computed using the formula Hovland, Gery, and Hake (Meltzer, 2002), as follows.

$$N-gain = \frac{S_{post}-S_{pre}}{S_{max}-S_{pre}}$$

Description

S_{post} = the posttes scores

S_{pre} = the pretes scores

S_{max} = the *maximum* maximum

N-gain = Normalized gain

With N-gain categories: high (g> 0.7), medium (≤ 0.3 g ≥ 0.7), and (g <0.3).

Furthermore, using SPSS 17 software performed tests of normality and homogeneity of data N- gain science students the generic skills of experimental and control classes followed by t-test. Two-sample of independent t-test used upper-tailed test of the research hypotheses.

Result and Discussion

Result

Description of Generic Science Students

In the present study has been conducted on the implementation APFE Moodle is a web-based system on Inorganic Chemistry lab courses. All the assessment tools used in the implementation APFE oriented on improving the generic science skills of prospective teacher students that integrated with mastery of the concepts corresponding to the experimental matter. Implementation APFE using computer facilities connected to the Internet network. The results of the implementation of the assessment model is expected to develop the generic science skills, relating to the symbolic language, modeling, and prospective teachers insight of spatial. Description of the generic science skills of prospective teachers students before and after implementation APFE on control and experimental class are presented on Table 1.

Tabel 1. Descriptive Statistic of Generic Science Skills Data

Variable	N	Minimum	Maximum	Mean	Std Deviation	Variance
PreExp	30	16.00	62.00	32.2667	12.83028	164.616
PreControl	30	16.00	36.00	26.9333	5.24525	27.513
PostExp	30	26.00	90.00	58.1333	17.88032	319.706
PostControl	30	28.00	54.00	37.0000	6.38425	40.759
NgainExp	30	.00	.83	.3713	.26131	.068
NGainControl	30	.00	.30	.1373	.07263	.005

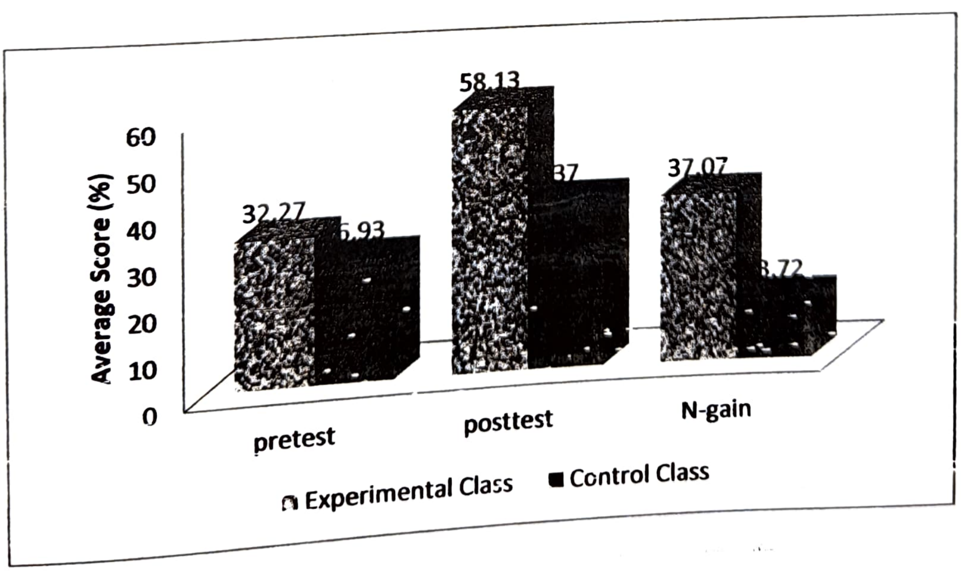


Figure 1. Average Score Description of Pretest, Posttest, and N-gain Experimental and Control Class

In Figure 1 it appears that the average pretest score for the experimental class at 32.27% and 26.93% for the control class. The average posttest score for the experimental class at 58.13% while the control class at 37%. Furthermore, average scores for the N-gain of experimental class is 37.07% and 13.72% for the control class.

Description of the average percentage of pretest, posttest, and N-gain score achievement of generic science skills indicators in a course grade of practical Inorganic Chemistry experiments and control class are presented in Table 3, Figure 2 and Figure 3.

In Figure 2 it appears that the experimental class students have the highest of the N-gain achievement (0.65) on symbolic language indicators. In contrast, the lowest N-gain score (0.03) in the logical frame indicators. For the control class (Figure 3) shows that the N-gain achievement highest scores on indirect observation and sense of scale indicators. The low N-gain on causality and logical frame indicators.

Tabel 3. Average score (%) of pretest, posttest and N- Gain of Generic Science Skills Practical Inorganic Chemistry

No.	Generic Science Skills Indicator	Item Test	Experimentall Class Average score (%)			Control Class Average score (%)		
			Pre-test	Post-test	N-gain	Pre-test	Post-test	N-gain
1.	Direct observation	1, 2, 17, 18, 35, 36	36,67	50,55	0,22	26,12	45,00	0,26
2.	Indirect observation	3, 19, 20, 37	29,17	47,50	0,26	23,33	50,83	0,36
3.	Sense of scale	4, 21, 38, 39	21,67	61,67	0,51	31,67	54,17	0,33
4.	Symbolic language	5, 22, 23, 40	25,83	74,17	0,65	38,33	44,17	0,09
5.	Logical frame	6, 24, 41	33,33	35,55	0,03	51,12	52,22	0,02
6.	Logical Consistency	7, 8, 25, 26, 42,46	37,22	54,45	0,27	22,78	28,33	0,07
7.	Causality	9,10, 43, 44	40,83	63,33	0,38	33,33	34,17	0,01
8.	Modeling	11, 12, 27, 32, 45	31,33	61,33	0,44	26,67	36,00	0,13
9.	Logical Inferences	13, 14, 15, 28, 29, 30, 47	36,67	61,90	0,40	21,90	32,85	0,14
10.	Abstraction	16, 31, 48,49	26,67	56,67	0,41	10,83	19,17	0,09
11.	Spatial	33,34,50	24,45	70,00	0,60	21,12	25,55	0,06

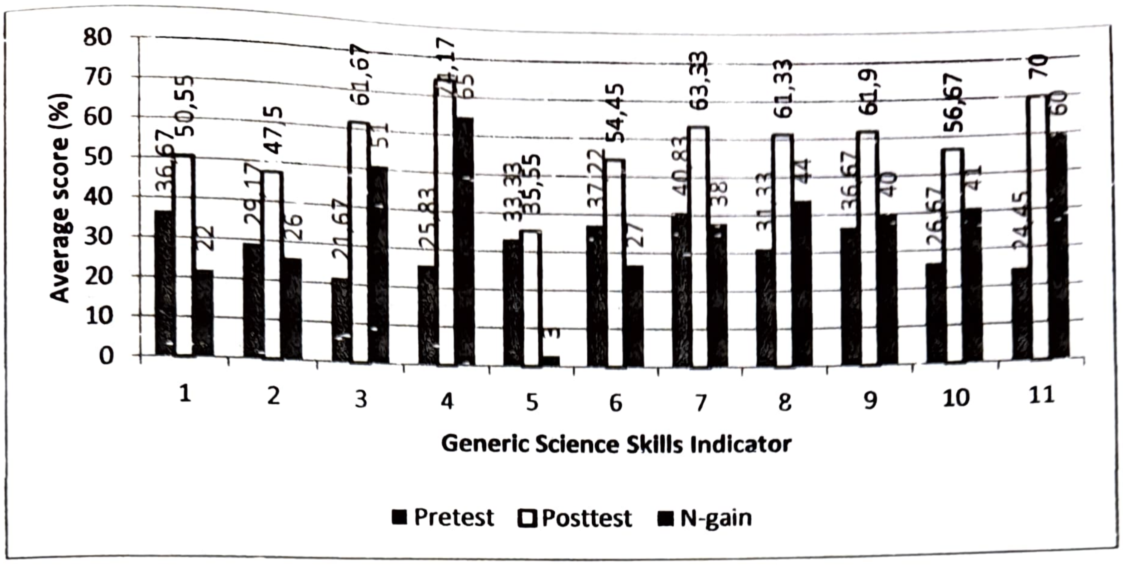
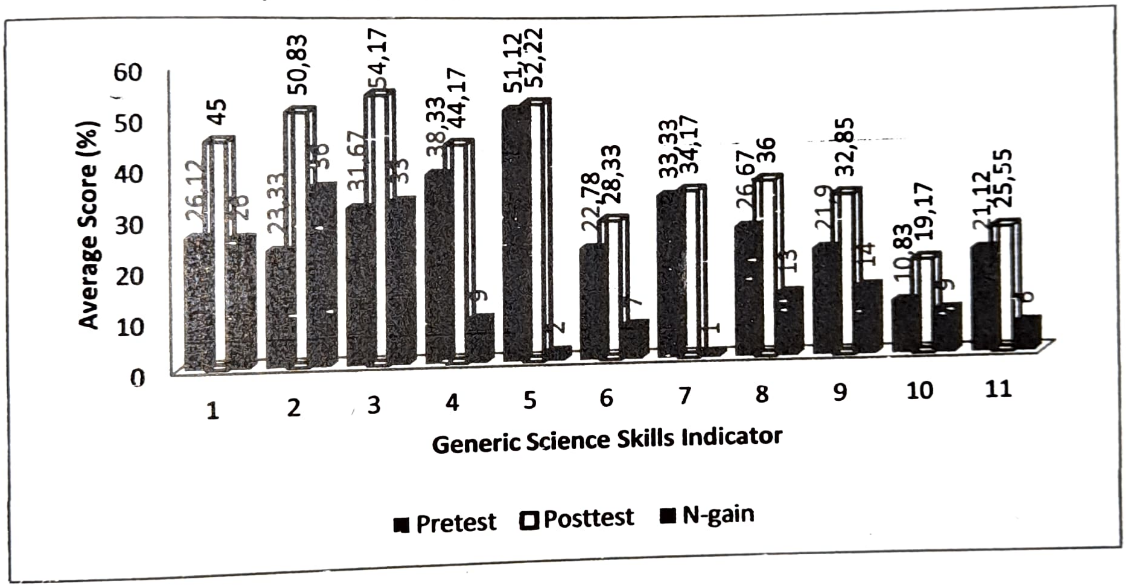


Figure 2. Average Score (%) of N-gain Generic Science Skills of Experimental Class



Description:

1. Direct Observation
2. Indirect Observation
3. Sense of Scale
4. Symbolic Language
5. Logical Frame
6. Logical Consistency
7. Causality
8. Modeling
9. Logical Inferences
10. Abstraction
11. Spatial

Figure 3. Average Score (%) of N-gain Generic Science Skills of Control Class

Mean average of two samples

Before the t-test, first the normality of the N-gain score of experimental and control class were tested . The results of normality test data using SPSS 17 is obtained that level of the significance of the N-Gain scores Kolmogorov-Smirnov test of experimental class and control class respectively of 0.200. Thus, it can be concluded that both types of data are normally distributed at the significance level, α = 0.05.

Table 2. Tests of Normality N-gain Score Data

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Group	Statistic	df	Sig.	Statistic	df	Sig.
NGain	Experimental Class	.119	30	.200*	.935	30	.067
	Control Class	.113	30	.200*	.965	30	.409

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

T-test of independent-sample t-tests against the N-gain two independent samples of one side to the upper tailed using SPSS has two outputs: first, the t test for two variances equal (equal variances assumed) was used if the results obtained in the homogeneity test is homogeneous. Second, the t test for equal variances are not homogeneous or not (equal variances not assumed) was used if the results obtained are not homogeneous in the homogeneity test (Uyanto, 2009).

Results of testing Ho: μ1 ≤ μ2 against H1: μ1> μ2 by using Levene's Test gives the value t = 4.726 with degrees of freedom, df = 33.455 with p-value (two-tailed) = 0.000 (Table 4). Because we do one-sided hypothesis tests (one-tailed) H1: μ1> μ2, then the value p-value (two-tailed) divided into 0.000 / 2 = 0.000. Since the p-value = 0.000 is smaller than α = 0.05, Ho: μ1 ≤ μ2 rejected. So it can be concluded that the average (mean) N-gain scores of chemistry teacher candidates are assessed using APFE better than the average student of N-gain score chemistry teacher candidates who are not assessed using APFE.

Table 4. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NGain	Equal variances assumed	41.832	.000	4.726	58	.000	.23400	.04952	.13488	.33312
	Equal variances not assumed			4.726	33.455	.000	.23400	.04952	.13331	.33469

Discussion

The results show that the implementation of APFE on practical Inorganic Chemistry can improve improve the generic science skills of prospective teachers students is higher than without APFE implementation. N- gains highest achievement in symbolic language indicator (0.65), spatial (0.60), awareness of the scale (0.51), and modeling (0.44). The N-gain achievement indicators is medium category.While the lowest category for logical frame indicators (0.03) with the low category. On the control class, the highest N-gain achievement in an indirect observation indicator (0.36) followed of sense of scale indicator (0.33), both in medium categories . Moreover, the the N-gain achievement of generic science skills indicator are at a low category.

Work on KPA and LKM quizzes that are the components APFE give feedback directly to students shortly after submit, so that prospective teachers can do reflection and conduct repairs on learning. In addition, the use of computer media in the implementation APFE facilitate prospective teachers more easily understand and interpret symbolic language, chemical equations and the geometry of the molecule by using the software chemSketch. This causes the occurrence of N-gain high achievement in the use of symbolic language, spatial, and modeling. Similar results were found by Sudarmin and Liliasari (2007) who developed a model of learning to take advantage of a computer found at the highest N-gain at modeling indicator (N-gain = 0.715). Symbolic language, sense of scale has N-gain in the high category. The use of computers in learning helps in developing generic skills of modeling, symbolic language, and abstraction chemistry teacher candidates through a visualization program images, symbols, and animations.

Conclusion

Based on the result of this research, it can be concluded that implementation of APFE were: (1) improve generic science skills, especially symbolic language, spatial, sense of scale, and modeling indicators, and (2) improving reflection and self assessment.

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